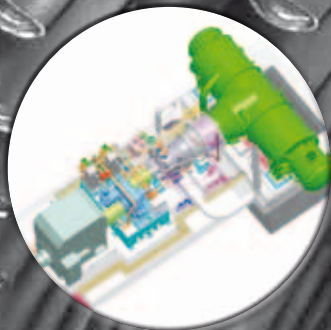




PBS ENERGO



Production Programme



About the company

PBS ENERGO, a.s. is focused on the supplies of steam and gas expansion turbines, turbo-sets and relating process and building systems.

PBS ENERGO, a.s. is a direct successor and owner of know-how of the PBS mark as a manufacturer of turbines and turbo-sets including their accessories.

The PBS traditions stretch back to 1814, when an engineering company was founded in Brno. The turbine production began in 1903 under the Parsons licence. The first turbine of own design was manufactured in 1906. The production of power equipment started in Velká Bíteš in 1951. In 1991, PBS Brno was divided, and a separate company was established under the name První brněnská strojírna Velká Bíteš, a.s.

In 2006 the organizational structure of První brněnská strojírna Velká Bíteš was changed. Complete know-how of steam turbines including their repairs, accessories and spare parts was put in the new company - PBS ENERGO, a.s., which has become the joint venture of První brněnská strojírna Velká Bíteš, a.s. and ČKD NOVÉ ENERGO, a.s.

Since its foundation, PBS ENERGO, a.s. is a modern firm whose activities are focused on high-tech products and services. PBS ENERGO, a.s. belongs to the Czech firms which are successful on both home and foreign markets.

As of August 2012, imAGe GROUP, a.s. has become a shareholder instead of ČKD KOMPRESORY, a.s.

In 2011, PBS ENERGO, a.s. was ranked among the „Czech Top 100“ firms in the competition organized by the pan-European society for culture, education, and scientific and technical collaboration COMENIUS.

In 2012, PBS ENERGO, a.s. was awarded the title of the Exporter of the Year in the category of small companies within the 15th EXPORT PRICE OF DHL UNICREDIT under the auspices of CzechTrade agency. High and continual quality of products belongs to basic attributes of presentation of the company on the markets. Thanks to the systematic efforts in the area of quality improvement the company has been certified according to ISO 9001, ISO 14001. PBS ENERGO, a.s. offers its customers reliability guaranteed by many-years' history and traditions which the company follows.

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STG I turbine installed

STG I and STG II steam back-pressure turbines

STG I and STG II steam back-pressure turbines are one of core products of PBS ENERGO and the result of long development efforts in the field with a long traditions. They have one or two turbine modules with high-speed shafts, on which overhanging end there is always one turbine wheel of the radial or axial turbine stage installed. The low-speed shaft of the gearbox with the usual speed of 3000 rpm or 1500 rpm is connected with the rotor of the power generator or other driven machine.

STG I turbines have one turbine module integrated with a high-speed transmission with spur gears, which contains one high-speed shaft with a speed of up to 28000 rpm.

STG II turbines have two turbine modules integrated with a high-speed transmission with spur gears, which contains two high-speed shafts with a speed of up to 28000 rpm.

The main advantage of the STG I and STG II turbo-sets is a higher efficiency in comparison with standard one-wheel turbines thanks to the use of high speed and a wide range of turbine stages of various types, which are always customized to reach a maximum efficiency of the turbine.

The STG II steam back-pressure turbines can be used for driving a generator and generating power as well as for driving feed pumps, compressors, fans or similar equipment.

Depending on the range of the controlled steam parameters, the STG I and STG II steam back-pressure turbines can be equipped with swivelling guide blades of the stator. The swivelling control increases overall efficiency of the steam turbo-set substantially in the non-design modes of the turbine run.

The STG II steam back-pressure turbines enable using controlled or non-controlled steam extraction from the transfer piping connecting the high-pressure and low-pressure modules on the steam side. The extraction pressure can be controlled in a wide range of flow by means of the swivelling guide blades of the low-pressure module.

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The **STG I** and **STG II** turbines are optimal for these parameters

Inlet steam

- » pressure: max. 65 bar abs.
- » temperature: max. 535 °C
- » flow rate: max. 60 t/h

Outlet steam

- » pressure: 1.2 bar abs. to 25 bar abs.

Shaft power

- » 100 kW to 8 MW

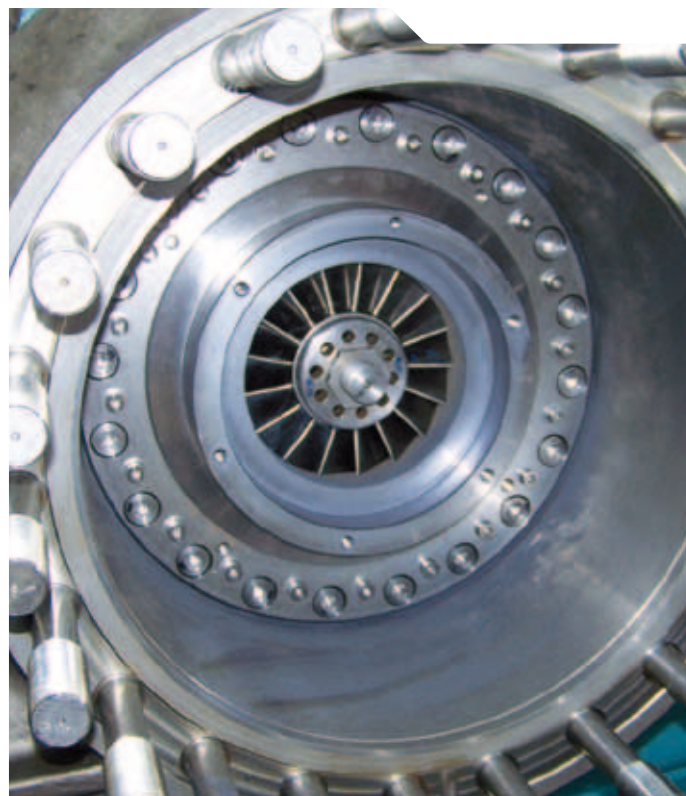


Selected references

- » **PEC Jelenia Gora**
- » **Koramo Kolín**
- » **Kaučuk Kralupy**
- » **ŽDB**
- » **Heating plant Holešovice, Prague**
- » **Heating plant Maloměřice**
- » **Heating plant Klatovy**



STG I turbine after its putting into operation



STG I turbine rotor

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Assembly of TG steam back-pressure turbine

TG axial steam back-pressure turbines

The design of the TG steam back-pressure turbines follows the traditional manufacturing base of the PBS industrial turbines. We offer turbines with one to two extractions.

The TG steam back-pressure turbines feature high efficiency and operational reliability with minimal operating costs. Consequently, we guarantee quick return of investment to our customers.

We offer both the turbo-set itself and turn-key delivery including all accessories and relating process systems. We provide comprehensive services from technical assistance, ensuring financing and planning of investments, complete design, manufacture, assembly, dispatch, commissioning, guarantee and post-guarantee servicing.

We design the steam back-pressure turbines according to the customer's specifications.

Financing

Last but not least, PBS ENERGO offers its customers various models of financing. In cooperation with financial institutions we are ready to offer our customers an **optimal financing model** for the construction of the plant itself as well as for the medium-term or long-term crediting.

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Basic parameters

Inlet steam

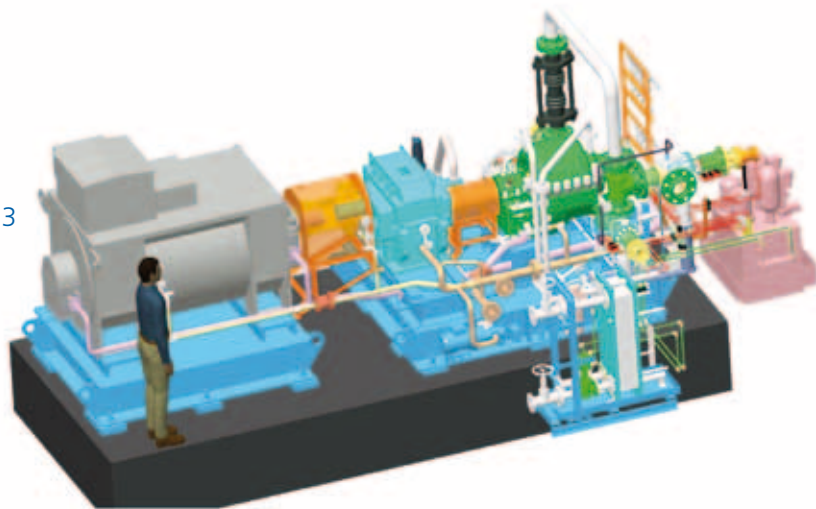
- » pressure: max. 110 bar abs.
- » temperature: max. 545 °C

Extraction steam

- » number of extractions (controlled/uncontrolled): 0 – 3

Shaft power

- » 1 MW to 15 MW



Selected references

- » **Chempex Lukoil**
- » **Kirovogradolija**



TG steam back-pressure turbine in commissioning



TG steam back-pressure turbine designed to drive a generator

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CSTG extraction condensing turbine

CSTG extraction condensing turbines

CSTG II and CSTG III extraction condensing turbines feature a modular design. They consist of STG I or STG II high-pressure module and CSTG condensing module, which are connected to one power generator or other driven machine.

In so called **tandem arrangement** both modules are installed on opposite sides of the power generator, and are connected to the rotor of the generator on its both ends.

In so called **parallel arrangement** both modules are installed side by side with parallel rotors, and are connected to the rotor of the generator on its one side.

The steam exiting the high-pressure module is led into the condensing module by a transfer piping in both arrangements.

In their power category, the CSTG II and CSTG III turbo-sets have a higher efficiency than conventional multi-stage turbines. This advantage is given by mutually independent selection of optimum speed of the modules and by use of an optimal turbine stage of the high-pressure module.

They combine the competitive advantages of high-pressure overhung STG turbines and low-pressure CSTG axial condensing turbines.

The advantage of the modular design in the tandem arrangement is the possibility of operation in both fully condensing (without technological extraction of steam) and fully back-pressure mode (without steam condensation in a condenser). Such a range of operating conditions is enabled by independent regulation of the back-pressure and condensing modules, with possibility of disconnection and reconnection of the low-pressure condensing module of the turbo-set by means of an automatic coupling without shutdown of the whole machine. This is why the turbo-sets are often installed in plant with a very variable steam extraction. With big extraction it is possible to disconnect the condensing module permanently automatically, which brings the user the advantage in a decrease of the amount of steam generated in the boiler by the amount, which is necessary for cooling of the connected condensing module at idling. Such regulation brings fuel and cost savings.

The CSTG II and CSTG III turbo-sets can be used for driving generators as well as compressors and pumps. They are especially suitable for smaller units burning bio fuel (chips, straw, briquettes, etc.).

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CSTG II and CSTG III turbines are optimal for these parameters

Inlet steam

- » pressure: max. 42 bar abs.
- » temperature: max. 500 °C
- » flow rate: max. 20 t/h

Extraction steam

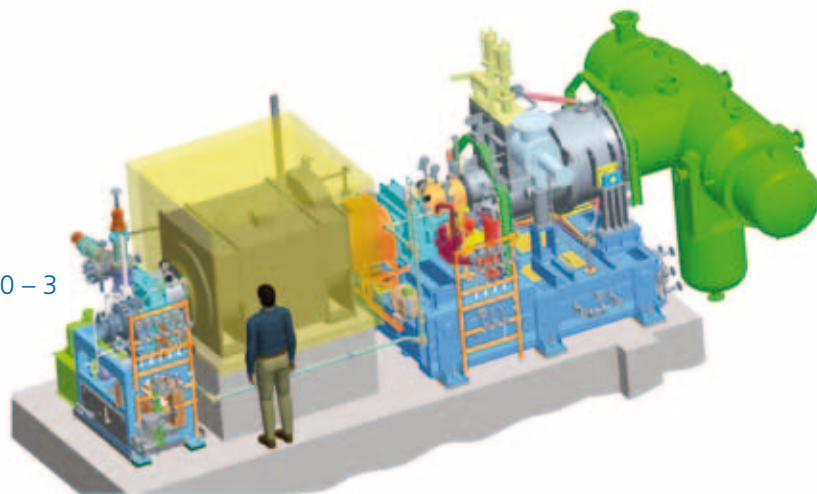
- » pressure: 1.2 bar abs. to 8 bar abs.
- » number of extractions (controlled/uncontrolled): 0 – 3

Outlet steam

- » pressure: 7 kPa abs. to 25 kPa abs.

Shaft power

- » 700 kW to 3 MW



Selected references

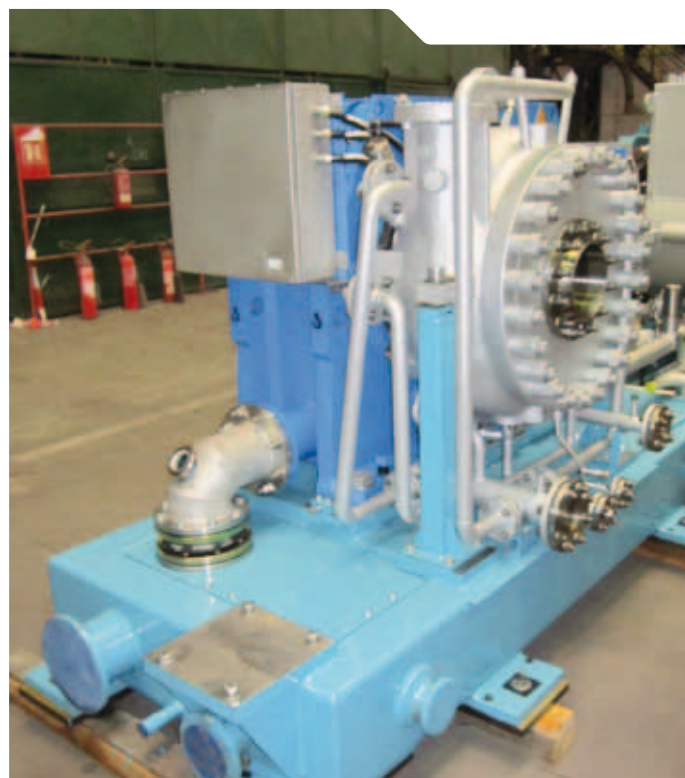
- » **Iromez Pelhřimov**
- » **Jaroslavl**
- » **Návsí**

Financing

Last but not least, PBS ENERGO offers its customers various models of financing. In cooperation with financial institutions we are ready to offer our customers an **optimal financing model** for the construction of the plant itself as well as for the medium-term or long-term crediting.



CSTG extraction condensing turbine



CSTG extraction condensing turbine

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TG extraction condensing turbine

TG axial extraction condensing turbines

The design of the TG extraction condensing turbines follows the traditional manufacturing base of the PBS industrial turbines. We offer turbines with one to two controlled extractions and one uncontrolled extraction for condensate regeneration.

The TG extraction condensing turbines feature high efficiency and operational reliability with minimal operating costs. Consequently, we guarantee quick return of investment to our customers.

We offer both the turbo-set itself and turn-key delivery including all accessories and relating process systems. We provide comprehensive services from technical assistance, ensuring financing and planning of investments, complete design, manufacture, assembly, dispatch, commissioning, guarantee and post-guarantee servicing.

We design the extraction condensing turbines according to the customer's specifications.

Financing

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Basic parameters

Inlet steam

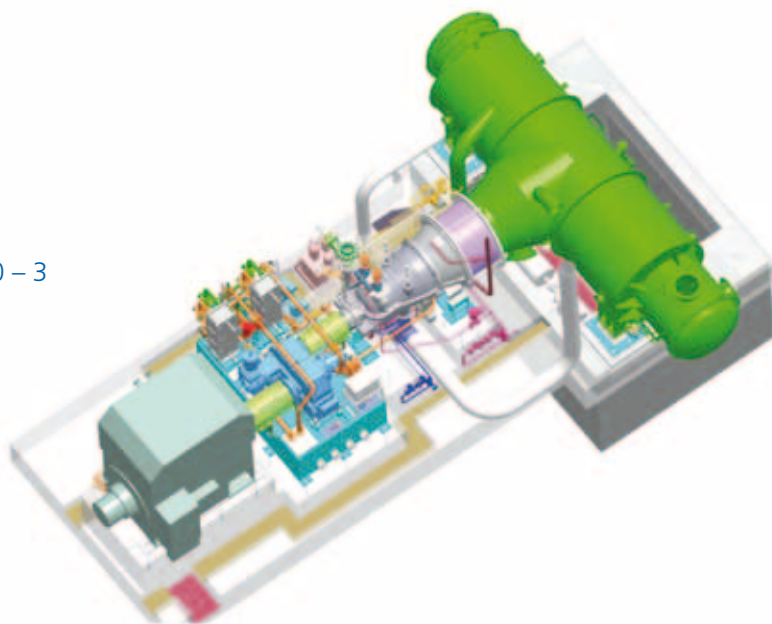
- » pressure: max. 110 bar abs.
- » temperature: max. 545 °C

Extraction steam

- » number of extractions (controlled/uncontrolled): 0 – 3

Shaft power

- » 2 MW to 30 MW



Selected references

- » **Bio power plant Kutná Hora**
- » **ČEZ Dvůr Králové**
- » **Mostek**



Swivelling control diaphragm of a extraction condensing turbine



Assembly of the extraction condensing turbine

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Low-pressure condensing turbine

Low-pressure condensing turbines

The low-pressure condensing turbines are often installed on the steam side in series downstream of the existing steam back-pressure turbines. Such arrangement brings an optimum power of both the boiler and the existing back-pressure turbine due to the fact that the newly installed low-pressure condensing turbine equalizes non-uniform heat of-f-takes from the outlet of the back-pressure turbine.

Effective solution of the additional installation of the condensing turbine consists in the connection of the CSTG turbine to the shaft of the existing generator on the side opposite to the back-pressure turbine. After it, it is possible to start and shut down the CSTG turbine without interruption of the run of the existing back-pressure turbine thanks to a special automatic coupling. The saving of investment expenditures as a result of complete preservation of the power outlet and minimization of cost of the other process systems and buildings is also undoubted advantage.

The CSTG turbines have barrel-type casings, without horizontal parting plane. This technical solution enables more flexible operation thanks to a shorter time of heating and cooling of the casings in turbine start-up and shutdown.

Financing

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CSTG turbines are optimal for these parameters

Inlet steam

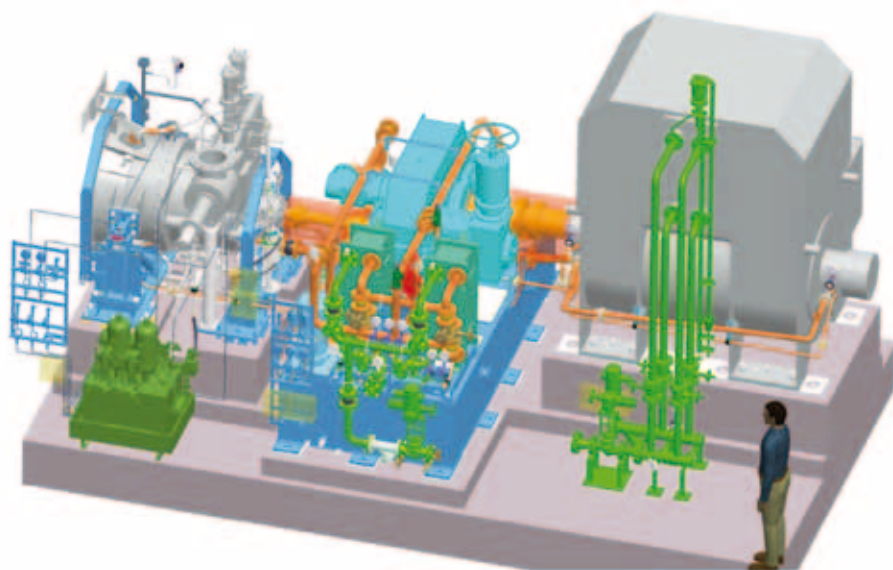
- » pressure: max. 15 bar abs.
- » temperature: max. 350 °C
- » flow rate: max. 90 t/h

Outlet steam

- » pressure: 5 kPa abs. to 25 kPa abs.

Shaft power

- » 500 kW to 15 MW



Selected references

- » **Mondi Ružomberok**
- » **Dalkia Krnov**
- » **Fergana Uzbekistan**



Low-pressure condensing turbine



Low-pressure condensing turbine

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ETG I gas expansion turbine

Gas expansion turbines

ETG I and ETG II gas expansion turbines serve for effective reduction of gas pressure in gas regulation and valve stations of gas distribution networks, in underground gas storages, chemical plants, systems of compressed mine gas, cold and hot air, nitrogen, etc.

Gas expansion turbines are turbo-sets whose design is based on the STG I and STG II steam turbines adapted to different flow medium. Differences are mainly in materials and the design of flow parts and external seals on the shaft. The turbines are mainly used for driving power generators.

Depending on inlet and outlet parameters of the flow medium, regulation is often implemented by setting of angle of the guide blades, which makes it possible to reach optimal efficiency in a wide range of gas flow rate even with varying gas expansion pressure in the turbine.

The gas expansion turbines are also designed for explosive environment - e.g. turbines working with natural gas or turbines for driving air compressors. Naturally, necessary certificates and inspection reports are delivered.

The turbines are delivered including their installation in the machine room or outdoors.

Advantages of the gas expansion turbines

- » Effective use of pressure drop
- » Quick and precise regulation of outlet pressure
- » High efficiency of the turbo-set
- » Minimization of gas leak

Financing

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Basic parameters

Medium

- » Natural gas
- » Nitrogen
- » Mine gas
- » Blast furnace gas
- » Coke gas

Inlet

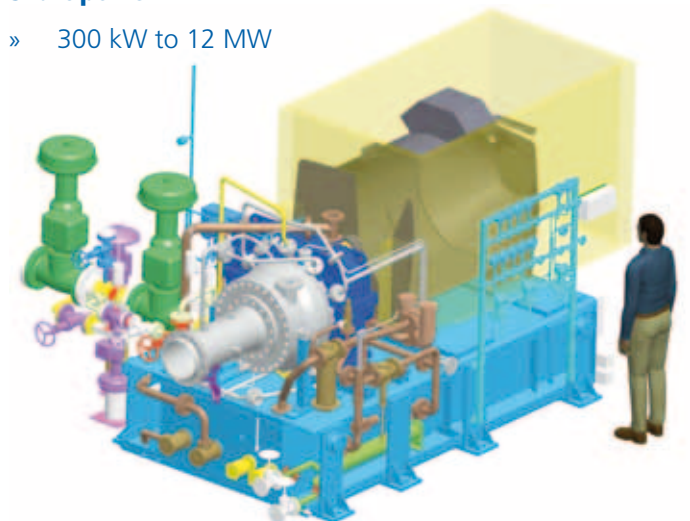
- » pressure: max. 65 bar abs.
- » temperature (depending on medium): max. 535 °C
- » flow rate: max. 300 thousand Nm³/h

Outlet

- » pressure: 0.1 bar abs. to 12 bar abs.

Shaft power

- » 300 kW to 12 MW



Selected references

- » **Nitrogenművek**
- » **Grodno**
- » **Jihomoravská plynárenská**



Installed ETG I gas expansion turbine



ETG I gas expansion turbine

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PC 850 driving turbine

Mechanical drive turbines

PBS ENERGO's turbo-sets can be used for the generation of electrical energy i.e. to drive power generators, or to drive other equipment.

The PBS ENERGO's power turbines feature high reliability, quick start, and high efficiency.

The power turbines are delivered with possibility of their installation in outdoor room as well as in an explosive environment.

Driven equipment

- » Compressors
- » Pumps
- » Fans
- » Crushers
- » Mills etc.

The turbo-sets can be delivered separately or together with the driven equipment.

The driving turbine type is given by the requirements for the run of the driven equipment, operating mode and required efficiency.

Financing

Last but not least, PBS ENERGO offers its customers various models of financing. In cooperation with financial institutions we are ready to offer our customers an **optimal financing model** for the construction of the plant itself as well as for the medium-term or long-term crediting.

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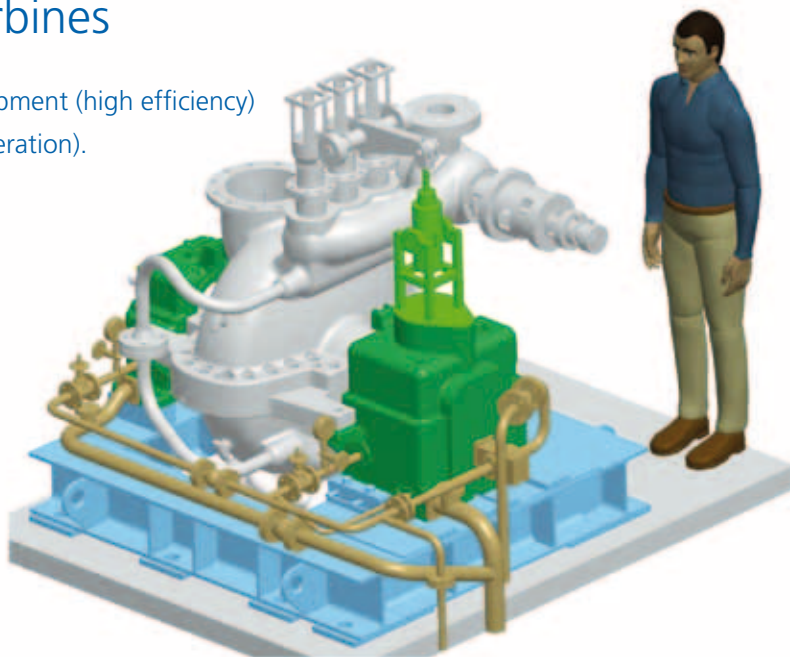
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PBS ENERGO supplies the below specified types of Mechanical drive turbines

- » optimized for continuous operation of the equipment (high efficiency)
- » functioning as a standby (quick putting into operation).



Selected references

- » **Jaroslavl**
- » **Grodno**
- » **Aqua Styl Kralupy**



Steam condensing turbine driving a hydrogen compressor



PC 850 driving turbine with a feed pump

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Steam-jet vacuum pump

Heat exchangers, condensers

PBS ENERGO offers a wide range of power equipment for transmission of heat, i.e. heat exchangers and steam condensers.

The design of the heat exchangers and condensers is based on long experience of PBS with design of similar equipment. As a standard we perform thorough monitoring of operational reliability and efficiency and application of latest knowledge on the design of new equipment.

In particular this product group includes

- » Condensers
- » Typical and atypical tubular heat exchangers
- » Low-pressure and high-pressure heaters
- » Waste heat exchangers
- » Steam-jet vacuum pumps
- » Economizers
- » Seal steam ejectors and condensers
- » Tanks etc.

The design of the heat exchangers and condensers is adapted to specific conditions. We offer technical assistance in case of change of working conditions. Naturally, we provide stress analyses, drawings of pressure vessels, heat balance and heat transmission calculations.

Financing

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Selected references

- » **Mondi Ružomberok**
- » **Dalkia Krnov**
- » **Bio power plant Kutná Hora**



Condensing-jet vacuum pump



Condenser



Condenser



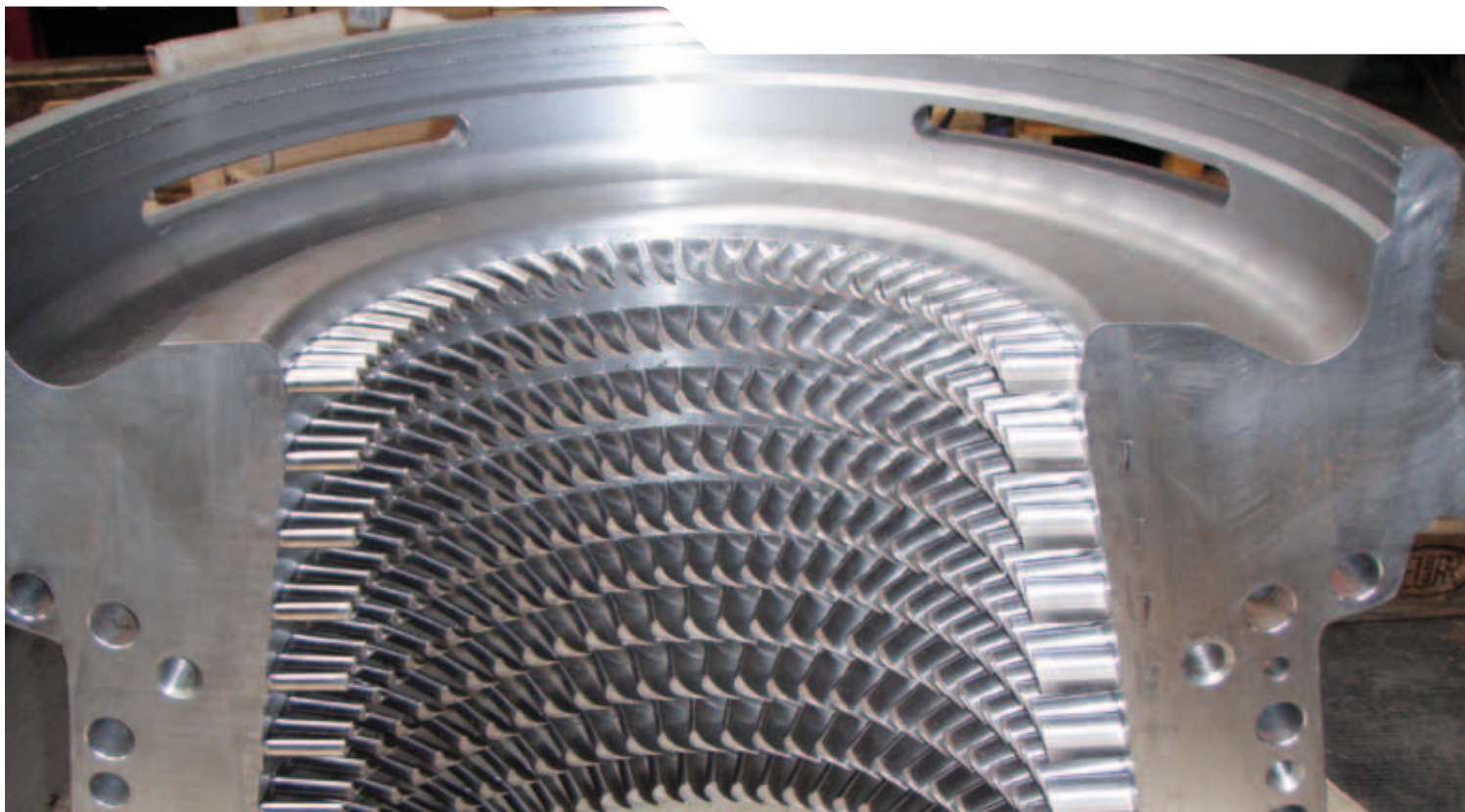
Low-pressure heater

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Exchange of stator blades

Spare parts

PBS ENERGO is a direct successor of the original PBS holding, and thus can use a complete archive of the production and supply documentation of all turbines manufactured by PBS.

PBS ENERGO offers overhauls of the entire turbo-sets, professional measuring and inspection of important parts of turbo-sets (bearings, blades ...) and preparation of complete inspection report. On the basis of the inspection results and findings we offer the spare parts which extend the life of the whole turbo-set including related guarantees.

PBS ENERGO covers a full range of spare parts for the turbo-sets. The spare parts include spare rotor and stator blades, turbine wheels, stator blade carriers, high-speed and low-speed gearbox shafts, bearings, parts and sets for control, heat exchangers, oil system, their components, etc.

PBS ENERGO guarantees the use/delivery of original spare parts directly from their manufacturers. For delivery of spare parts and in servicing we employ the latest procedures with application of our long experience as a turbine manufacturer in connection with the results of development of new products and technologies.

In case of interest on the part of the customer we are also able to replace the complete turbine based on the serial number of the turbo-set.

All spare parts are subject to strictest acceptance tests and inspection criteria before their dispatch to the end customer.

Advantages of ordering spare parts from PBS ENERGO

- » We guarantee original spare parts.
- » Spare parts will be manufactured precisely according to the manufacturing documentation and serial number of the respective machine.
- » We give full guarantee for the delivery of spare parts.
- » We are the owners of the original manufacturing documentation.

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List of selected types of turbo-sets

Machine type	Power (kW)
Mv400	10 - 200
Mv550	80 - 500
Mv700	120 - 700
PC400	40 - 200
PCPL700	300 - 1000
PCPL400	100 - 400
PC850	700 - 2 000
P28,1	28 100
P32	32 000
PA	1 900
PC1100	2 600
PC700/MEA	1 200
PR3,2	3 200
R3,35	3 350

Machine type	Power (kW)
K1,15	1 150
K4,3	4 300
K4,9	3 640
K5,5	5 500
K6,5	6 500
K7,15	6 660
P22,5	22 500
P28,1	28 100
T30	30 000
P30	30 000
R6	6 000
PT50	50 000
T12	12 000
TPP	3 350



Machining of turbine rotor



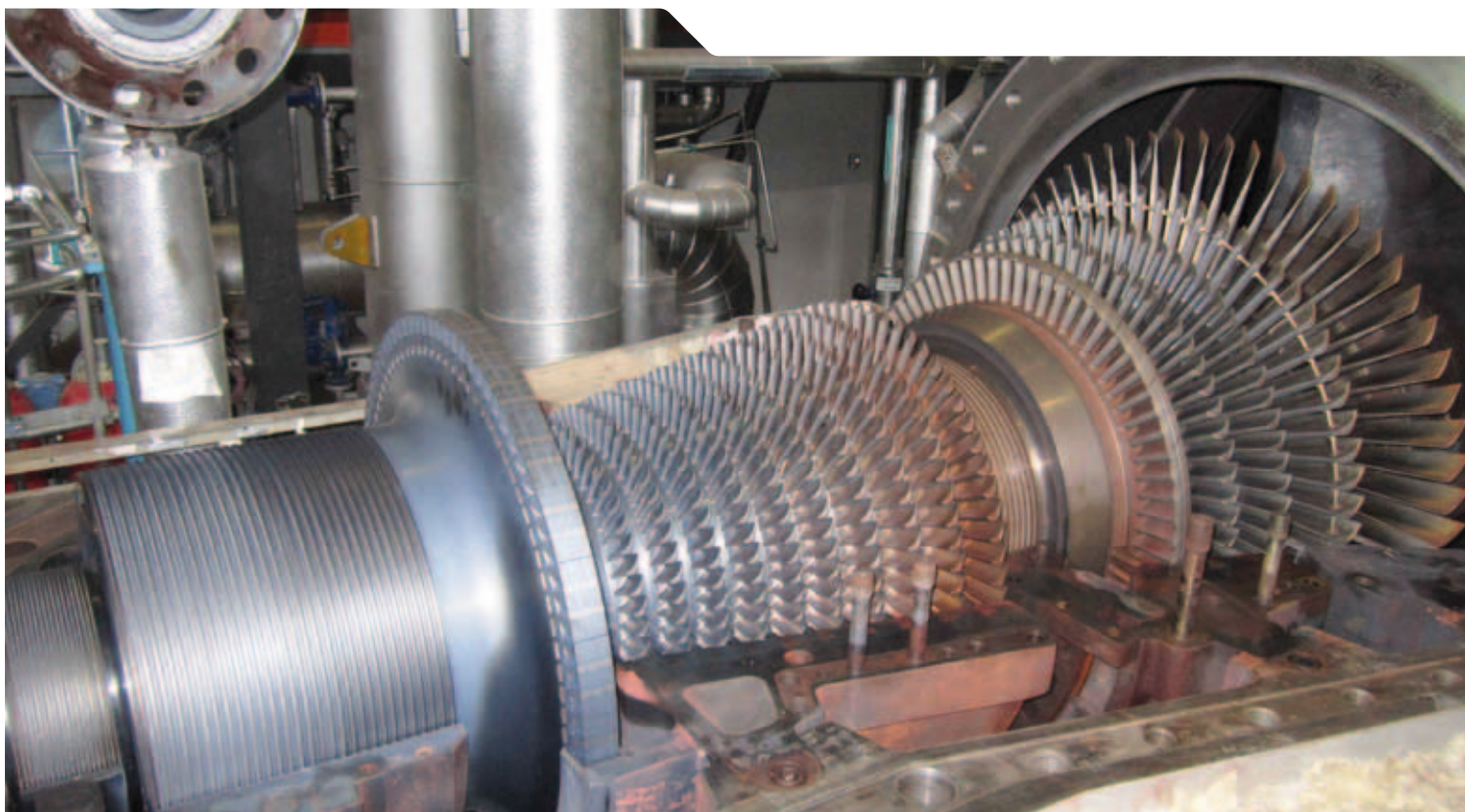
Exchange of rotor blades

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Overhaul of TG steam condensing turbine

Service activities

PBS ENERGO provides complete overhauls of the whole turbo-set including accessories. The range of service activities includes demounting of the whole turbo-set including accessories, complete measuring, expert assessment of current condition of the machine, elaboration of inspection report and its discussing with the customer, ensuring all necessary spare parts, making necessary repairs and modifications, remounting of the turbo-set and its putting into operation.

PBS ENERGO is the owner of complete documentation of the turbo-sets manufactured historically under the PBS trademark. We can find all documents necessary for servicing including measurement records, clearance setting, changes in production documents or similar according to the serial number of the machine.

Financing

Last but not least, PBS ENERGO offers its customers various models of financing. In cooperation with financial institutions we are ready to offer our customers an **optimal financing model** for the construction of the plant itself as well as for the medium-term or long-term crediting.

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Service activities

Complete range of service activities

We ensure all repairs of steam turbines within overhauls, but also in sudden failures or accidents. From the view of their extent, the performed repairs of turbines range from medium repairs of individual components to general overhauls of the machines including auxiliary equipment.

Reconstruction and changes in operating parameters

If the operator requires a change in operating parameters, we, within the service activities, also recalculate the turbo-set including design of flow parts. By optimization of the machine we improve the operational economy of the turbo-set with minimal costs arisen to the customer.

Modernization and automation of turbo-sets

PBS ENERGO performs modernization and automation of older turbo-sets. As a result, the technical standard of the existing turbo-sets gets close to the state of the art with preservation of the existing equipment. By modernization and automation it is possible to get optimal results of turbo-set operation, increase overall efficiency of the unit and minimize power losses.

Turbo-set replacement

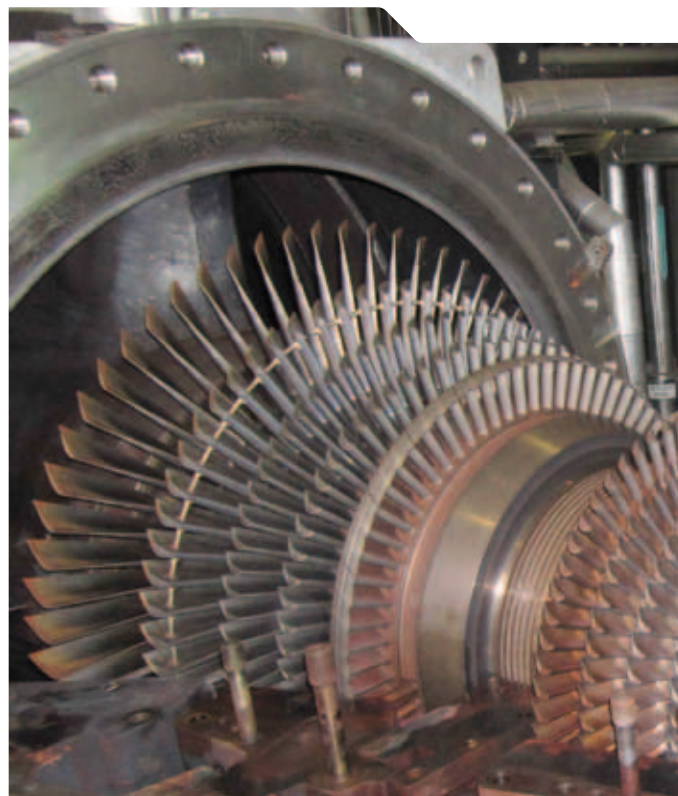
By agreement with the customer, we are ready to perform complete replacement of the turbo-set with preservation of the existing building layout, driven equipment as well as the relating process systems. In case of agreement with the customer, we replace the turbo-set that approaches its end of life by a new, the same or modernized one, or propose a new type, which meets new technological requirements in an optimum way.

Selected references

- » **ŽDB**
- » **Heating plant Strakonice**
- » **Momentive Specialty Chemicals Sokolov**



Assembly and overhaul of steam condensing turbine



Overhaul of TG steam condensing turbine

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Complete delivery of condensing steam turbine including technology and construction

General deliveries

PBS ENERGO deliveries include not only the delivery of the turbines themselves, but also relating process and building systems.

As standard, PBS ENERGO provides

- » Inlet and outlet piping including valves, orifice plates, diaphragms, steam and water injection and heat compensators.
- » Concrete foundation for the turbo-set including static and dynamic calculations.
- » Complete condensing part including condenser, condensate pumps, low-pressure or high-pressure heater, seal steam condenser, operating vacuum pump, starting and emergency ejectors.
- » Generator power outlet including control of voltage, power factor ($\cos \phi$) and synchronization, both high-voltage and low-voltage switchgear, power transformers, possibly island operation control.
- » Bridge crane or lifting equipment.
- » Cooling circuit including cooling towers, cooling water pumps, sumps, etc.
- » Compressed air generation and distribution circuits.
- » Complete instrumentation and control including data acquisition, storage and evaluation.
- » Buildings for above specified equipment.

The entire delivery forms a fully functional unit. The delivery includes complete installation, testing, debugging and commissioning of the equipment.

PBS ENERGO provides full range of activities in construction of power units with steam and gas expansion turbines. The delivery includes the planning, basic and detail design, implementation, installation, putting into full operation, guarantee and post-guarantee servicing.

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Financing

Last but not least, PBS ENERGO offers its customers various models of financing. In cooperation with financial institutions we are ready to offer our customers an **optimal financing model** for the construction of the plant itself as well as for the medium-term or long-term crediting.

Selected references

- » **Jihomoravská plynárenská**
- » **Bio power plant Kutná Hora**
- » **Iromez Pelhřimov**



Delivery and assembly of condenser



Delivery of heating water pipelines and controls



Complete delivery of gas expansion turbine

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Bio power plant

Bio power plants and heating units

PBS ENERGO and BFS ENERGO, a.s. have commissioned a complete bio power plant burning baled straw. The plant was put into operation in 2011, and power and operating parameters of the bio power plant were verified in 2012.

Now the consortium offers a turnkey construction of power units for combustion of biomass and co-generation of power and heat.

The consortium can provide complete design, manufacture and construction of power units, including ensuring financing of the entire project.

Together with financial institutions we help our customers to find an optimal way of return of the invested financial means.

Financing

Last but not least, PBS ENERGO offers its customers various models of financing. In cooperation with financial institutions we are ready to offer our customers an **optimal financing model** for the construction of the plant itself as well as for the medium-term or long-term crediting.



Project of Bio power plant

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Basic parameters

Fuel

- » biomass (straw, pellets, wood chips, power crops, etc.)
- » gaseous fuel (natural gas, biogas, coke gas, etc.)
- » liquid fuel (diesel, petrol, kerosene oil, burning oil, etc.)

Power units

- » 700 kW – 3 MW with the use of CSTG condensing extraction turbines
- » 3 MW – 30 MW with the use of TG condensing extraction turbines

Selected references

- » **Bio power plant Kutná Hora**



Bio power plant - heat exchanger station



Bio power plant - cooling tower



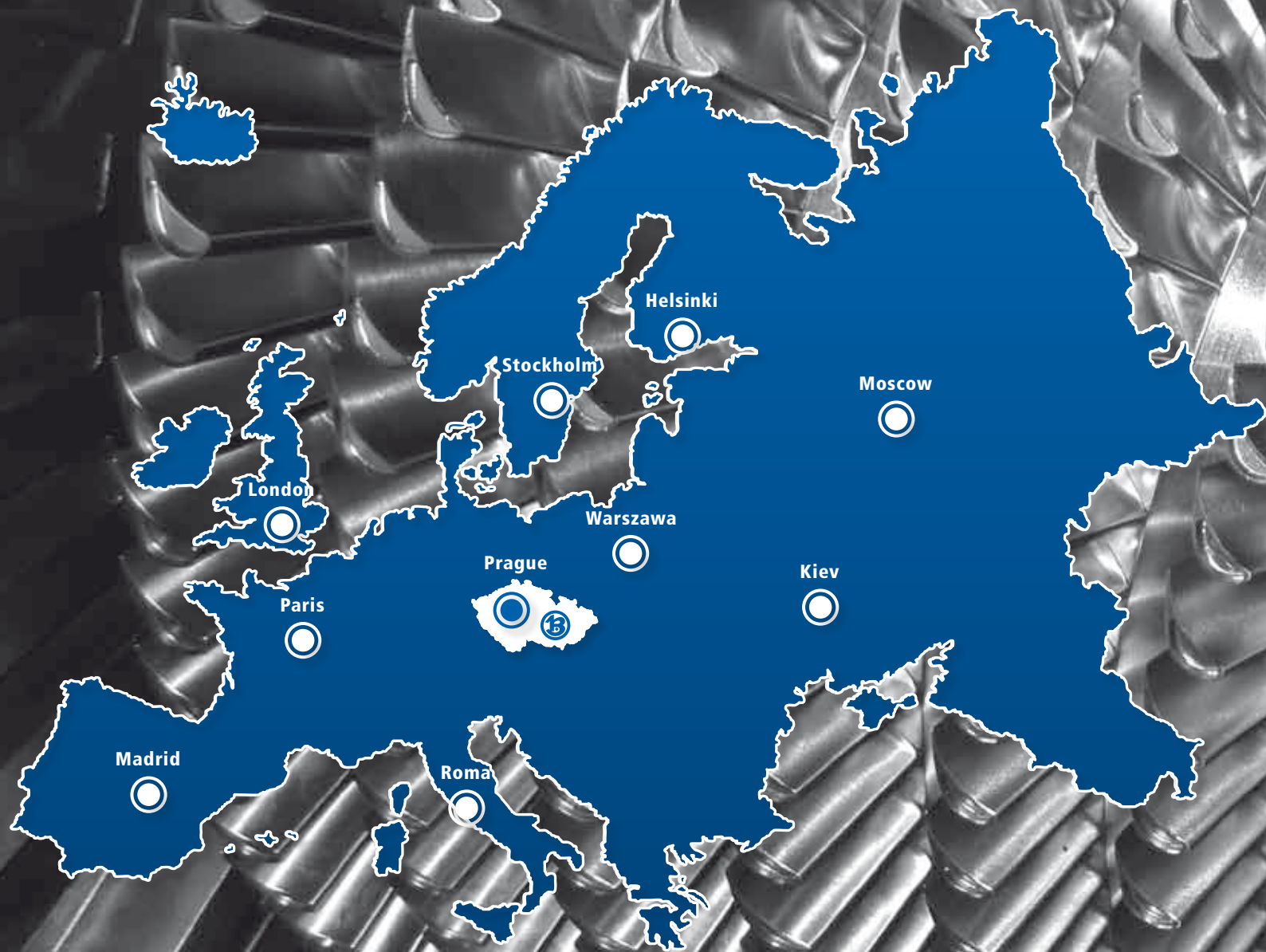
Bio power plant - biomass transport

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